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10/30/2015

## Computer Scientists Tap into Beehives

Oct. 30, 2015 – On a warm spring day at the USU Organic Farm, computer science professor Dr. Vladimir Kulyukin delivers a few puffs of sweet-smelling pine cone smoke into one of his beehives and gently opens the top. Everything appears normal, but it's not your average backyard beekeeping setup. Kulyukin's hives are equipped with electronics that monitor temperature, audio and video—all powered by solar energy and controlled by a credit card-sized Raspberry Pi computer.



*Vladimir Kulyukin, left, works with graduate student Sarat Kiran Andhavarap. (Matt Jensen/USU)*

The purpose of today's visit is not to collect honey or pose for a picture. Kulyukin and computer science graduate student Sarat Kiran Andhavarapu need to swap out one of the memory cards onboard the computer that's been collecting data for two weeks.

It's a routine chore for Kulyukin —a seasoned beekeeper who skips wearing the full-body suit and gloves —but a first-time experience for Sarat, who until now has never been this close to a swarm of busy bees.

Kulyukin has been interested in beekeeping for about five years. His motivation to look closer at what's affecting global bee populations came from a 2013 cover story in *Time* magazine about the mysterious collapse of bee colonies around the world.

He proposed a simple system to collect data from beehives with the goal of creating a method for both small and large-scale beekeepers to keep better track of changes in the hive. If the audio profile inside the hive changes significantly from one day to the next, the beekeeper could be notified by email and have time to investigate.

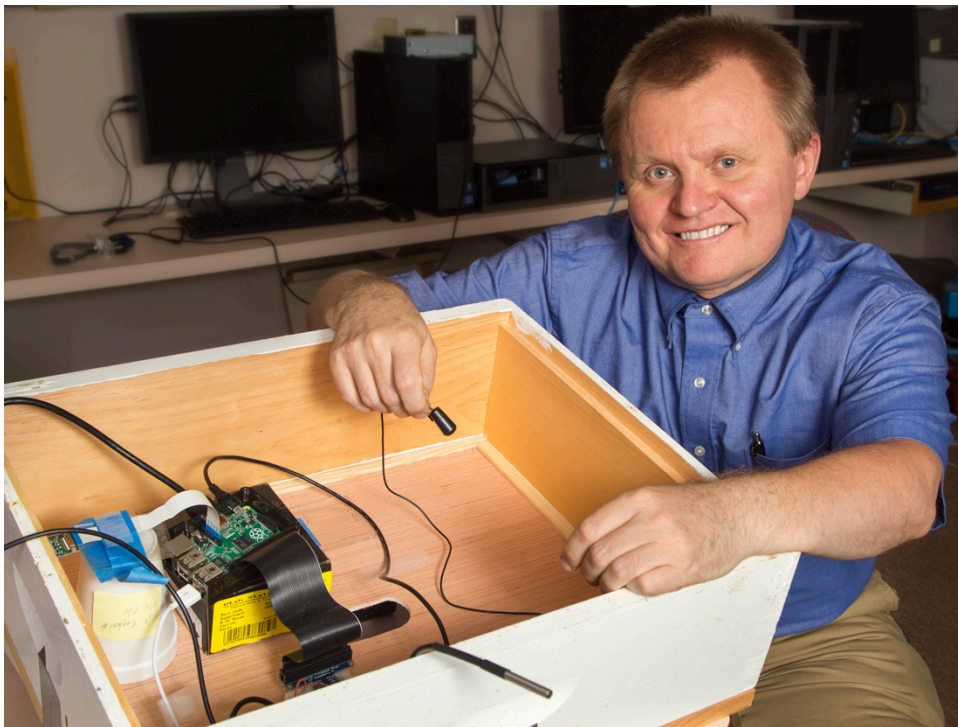
"The camera, microphone and temperature probe capture intermittent snapshots," said Kulyukin. "These snapshots are used to estimate the amount of bee traffic in and out of the hive. The audio files will be analyzed to identify significant events in the hive. For example, are there buzzing patterns that indicate the queen is beginning to fail?"



Temperature readings tell Kulyukin if the hives are in good repair. A rapid decline may point to external damage to the hive. With funding from the Micron Corporation, Kulyukin set out to construct three beehive monitoring systems at the USU Organic Farm in North Logan and another system in Garland, Utah. Each beehive system, which the researchers dubbed "BeePI," is made up of a miniature camera, solar panel, temperature sensor, battery, hardware clock, solar charge controller, and, of course, the Pi computer. A future addition of a Wi-Fi card will allow beekeepers to extract data without manually removing SD cards.

Remote beehive monitoring isn't new. Fellow researchers have been exploring ways to better understand hive conditions for several years, but there are still a lot of unanswered questions. Kulyukin's research is focused on creating a reliable solar energy and a battery storage system for the monitors and developing inexpensive ways to construct the units with commonly available off-the-shelf supplies.





“A major objective of our project is to transform standard bee yards into distributed solar-powered multi-sensor data clusters that collect and analyze large volumes of live data in real time,” he explained. “This type of monitoring system will also enable researchers and practitioners to collect objective data on different bee species and different hive designs.”

Kulyukin’s research also gives his computer science students a practical application for their skill set.

“Recruiting and retaining excellent undergraduate CS majors is challenging,” he said. “Students enrolled in CS courses often complain that many covered topics lack practical significance. This project demonstrates that CS is not only practical, but also highly relevant to areas that seemingly have little to do with computation such as beekeeping, entomology, and environmental science.”

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